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Dielectric relaxation phenomenon based on the fractional kinetics: Theory and its experimental confirmation

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Abstract

In this short paper, we outline the basic results obtained for dielectric relaxation based on the fractional kinetics. One can prove that many self-similar dynamical processes taking place in microscopic scales are averaged on the mesoscale and from the mathematical point of view these averaged motions accept power-law dependence with real or complex-conjugated exponents. This means that in the region of the mesoscale the kinetic equation for the total polarization is described by equations containing non-integer operators with real or complex-conjugated exponents. This approach helps us to understand some empirical expressions (Cole-Cole and Cole-Davidson) suggested for the description of the complex permittivity in the frequency domain. Besides, this theory suggests new expressions for complex permittivity that follow from the stationary solution of equations containing non-integer differential operators. This theory is confirmed by experimental measurements; in particular, it helps us to understand the generalization of the empirical Vogel-Fulcher-Tamman (VFT) equation that relates the behavior of any extreme point of the dielectric spectra with temperature. For the first time, the kinetic processes that are described by real and complex-conjugated power-law exponents are confirmed experimentally in polymerization vitrification reactions.

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